




809

SMM

SELECTED SOLAR FLARE IMAGE SERIES

80-014A-07A



SMM

SELECTED SOLAR FLARE IMAGE SERIES

80-014A-07A

THIS DATA SET CONSIST OF ONE 3.5 INCH FLOPPY DISK, WRITTEN ON A DOS MACHINE IN ASCII FORMAT. A DUPLICATE DISK WAS MADE AND PUT IN THE BACK-UP STORAGE AREA.

KF#	FILES
KF000060	125

The GRS Data Sampler

This demo was produced on a 1.2MB diskette for Hercules or VGA graphics.

This is version 2.0 of the GRS Data Sampler produced at the University of New Hampshire by the SMM/GRS Gamma Ray Team (May 1991). Future versions may contain more flares and bursts or those of greater interest. We hope to have background data for the Cosmic Burst data in the next version of this sampler. If you have any comments please contact us using the information given below.

This work was supported under NASA grant NAG5-720.

To start the demo:

Place the diskette into a 1.2 MBV disk drive
Next set default to the drive with the demo disk
Type GRSDATA and hit <RETURN> to start the demo
After the Screen Show screen comes up then Hit RETURN
The demo will direct you from there

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An Introduction to the Gamma-Ray Spectrometer on SMM

1 INTRODUCTION

Gamma-Ray Instruments which have produced significant amounts of data and also have spectroscopic capabilities at energies >1 MeV, are limited to a few satellite experiments. These include the solar Gamma-Ray Experiments on OSO-7, SMM and Hinotori and the two cosmic Gamma-Ray Experiments on HEAOa and HEAOc. Among these, the Gamma-Ray Spectrometer on SMM is unique for at least two reasons, the nearly 10 year length of its data set and the excellent gain/operational stability of the instrument over its full operational life.

The GRS/SMM was originally designed to measure transient gamma-ray emission associated with solar flares and cosmic bursts. The catalog of >250 solar flares and some 170 cosmic bursts attest to its success in detecting these events. Flare data from GRS/SMM have been used to demonstrate the existence of nuclear line emission early in the impulsive phase of flares, detection of high energy solar neutrons and pions, the discovery of the 154 day period in flare activity, the existence of disk center to limb variations in flare properties and a study of elemental abundances at the flare site, among other topics. Its sensitivity at high energies have been used to show that emission >1 MeV in Cosmic Bursts is much more important than previously thought.

Although designed as a transient instrument, the long data record and excellent instrument stability has allowed the GRS data to be used to study Cosmic Source gamma-ray emission. These include the 0.511 MeV and Al26 lines as well as the gamma-ray continuum to energies >10 MeV from the galactic center and disk and the first detection of lines from SN1987a. Other results include the terrestrial albedo gamma-ray line spectra and the discovery of emissions from satellite nuclear reactors. The range of scientific discoveries and observations made with GRS/SMM, is meant to indicate its richness and suggests the GRS Data Set contains much more untapped scientific results.

2 GRS Instrument

The GRS Instrument consists of three, largely independent, sensor systems. These are the X-Ray Detectors (X1 and X2), the Main Channel Spectrometer (MC) and the High Energy Monitor (HEM). All three are designed to record the energy loss spectra produced by neutral radiation including, in the case of the HEM, solar neutrons. The instrument also includes several "charged particle" and "Compton suppression" active shields which surround the MC and HEM. Table I-1 summarizes some of the parameters for each sensor system (see also, Forrest et al, 1980).

A Scientific Description of the GRS Instrument containing information about the GRS Instrument which is required for scientific analysis of the data is also available upon request. It includes preflight and inflight energy calibration, a response function for each of the three sensors, and a description of the physical and electrical properties of the instrument including its location within the SMM spacecraft.

Table I-1 GRS Sensors

The X-RAY DETECTORS - Two Detectors X1 and X2, each produce a 4-Channel Spectrum every 1.024 seconds.

Geometric area		7.9 cm ²
50% Transmission	X1	14 keV
	X2	35 keV
Energy Resolution		30% FWHM at 60 keV
Nominal Energy at		X1 = 14: 21: 35: 56: 114 keV
Channel Boundaries		X2 = 14: 28: 56: 114: 199 KeV

THE MAIN CHANNEL GAMMA RAY SPECTROMETER - Seven NaI Detectors produce a "SINGLES" and a "MULTIPLES" Spectrum every 16.384 seconds.

Geometric Area	317 cm ²
Energy Resolution	7% FWHM at 0.662 MeV
Energy Band	0.3 - 9.0 MeV
50% Transmission	200 keV
Burst Window Energy Band	0.064 sec. readout time ~300 to 350 keV

Main Channel Windows	2.048 sec. readout time
Energy Band	3 windows covering 4.1 - 6.4 MeV

THE HIGH ENERGY MONITOR (MATRIX) - The seven NaI Detectors and the Back CsI detector produce an 18 element Matrix output every 2.048 seconds.

Geometric Area	NaI = 317 cm ² , CsI = 491 cm ²
Energy Band	10 - 140 MeV

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The SMM Gamma Ray Spectrometer On-Line Information System

In order to make the rich GRS data base more accessible to the scientific community, the SMM GRS group at UNH has produced an on-line menu driven information system which allows any interested person to browse the GRS Flare and Cosmic gamma ray burst data base. The on-line information system can be used to; find the status of the GRS instrument at any time during its decade long mission, plot sample energy bands for any GRS flare or burst as well as mail sample data sets for any flare or burst over the network. There are on-line instructions as well as the latest news.

The UNH GRS Information System can be reached via SPAN or the Internet by Telnet using the following addresses:

SPAN

HOST Address: 7100
USERNAME: GRSDATA

Internet

Telnet Address: UNHSMM.UNH.EDU
USERNAME: GRSDATA

No password is required.

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If you have any questions concerning this demo or would like more information, please contact any of the following at UNH:

Tom Vestrand	(GRS PI) Telephone (603) 862-2653
Dave Forrest	(GRS Instrumnet Scientist) Telephone (603) 862-3705
Ken Levenson	(Data manager) Telephone (603) 862-3708

or write to any of the above individuals at the following address:

The Space Science Center
The University of New Hampshire
Durham, NH 03824

Volume in drive A has no label
Volume Serial Number is 14E7-2D51
Directory of A:\

GRSBILL1	GX2	1,097	05-09-91	4:29a
GRSBILL2	GX2	1,383	05-09-91	4:34a
GRSBILL3	GX2	2,417	05-09-91	4:42a
HF0183	GX2	6,233	04-07-91	10:04p
FRONT	EXE	33,987	01-01-80	12:05a
HF1057	GX2	6,465	04-07-91	10:05p
INSTR4	GX2	769	05-18-91	8:44a
HDDEMO	SHW	382	05-19-91	12:06p
SHOW	EXE	99,296	12-03-88	4:18p
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HF2034	GX2	6,391	04-07-91	10:08p
HF2166B	GX2	6,231	04-07-91	10:12p
HF2191D	GX2	6,264	04-07-91	10:13p
HF2347	GX2	6,582	04-07-91	10:09p
HF4126	GX2	6,366	04-07-91	10:15p
HF8105	GX2	6,442	04-07-91	10:17p
HF8176	GX2	6,523	04-07-91	10:16p
HF9219	GX2	6,620	04-07-91	10:19p
HF9252	GX2	6,642	04-07-91	10:20p
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HHEADR2	GX2	5,072	04-07-91	10:47p
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HFDEMO1	GX2	2,005	04-07-91	10:50p
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HFDEMO3	GX2	2,276	04-07-91	10:54p
HFDEMO4	GX2	6,159	04-07-91	10:57p
HFDEMO5	GX2	2,331	04-07-91	10:58p
HFDEMO6	GX2	8,202	04-07-91	11:00p
HFDEMO7	GX2	2,599	04-07-91	11:01p
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HFDEMO9	GX2	4,867	04-07-91	11:04p
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VFDATA	SHW	1,062	05-19-91	8:25p
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VFDEMO5	GX2	2,825	04-08-91	12:39p
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VFDEMO8	GX2	8,915	04-08-91	12:48p
VFDEMO8B	GX2	9,238	04-08-91	12:51p
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VF2191D	GX2	11,069	04-08-91	1:04p
VF4126	GX2	11,299	04-08-91	1:05p
VF8176	GX2	11,626	04-08-91	1:06p
VF8105	GX2	11,455	04-08-91	1:07p
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VF9252	GX2	11,812	04-08-91	1:09p
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HBDEMO2	GX2	1,209	05-21-91	11:26a
HBDEMO3	GX2	2,078	05-21-91	11:26a
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HBDEMO7	GX2	6,355	05-21-91	11:55a
HBDEMO8	GX2	4,943	05-21-91	1:38p
HBDEMO9	GX2	928	05-21-91	11:33a
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HC1365	GX2	5,658	05-19-91	9:03p
HC2079	GX2	5,598	05-19-91	9:25p
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HC3021	GX2	5,572	05-19-91	9:07p
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HC8298	GX2	5,601	05-19-91	9:13p
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VC1226	GX2	8,873	05-20-91	11:07a
VC1365	GX2	8,940	05-20-91	11:09a
VC2079	GX2	8,893	05-20-91	11:11a
VC2308	GX2	8,872	05-20-91	11:13a
VC3021	GX2	8,892	05-20-91	11:14a
VC4340	GX2	8,966	05-20-91	11:15a
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VC6051	GX2	8,901	05-20-91	11:18a
VC7160	GX2	8,651	05-20-91	11:24a
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VC8298	GX2	8,987	05-20-91	11:26a
VC9240	GX2	8,903	05-20-91	11:27a
VBDEMO1	GX2	1,877	05-21-91	2:11p
VBDEMO2	GX2	1,628	05-21-91	2:13p
VBDEMO3	GX2	2,351	05-21-91	2:14p
VBDEMO4	GX2	7,551	05-21-91	2:16p
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VBDEMO6	GX2	3,905	05-21-91	2:18p
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HBHEAD4	GX2	1,057	05-22-91	10:03a
VBHEAD4	GX2	1,463	05-22-91	1:32p
VFHEAD4	GX2	1,446	05-22-91	1:31p
ADL	DAT	0	11-20-96	9:55a
12 8 file(s)		761,826 bytes		
5		658,432 bytes free		

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UNIVERSITY OF NEW HAMPSHIRE

W. Thomas Vestrand
Space Science Center
Institute for the Study of
Earth, Oceans and Space (EOS)

Science and Engineering Building
Durham, New Hampshire 03824
Telephone No. [603] 862-2653
Telefax No. [603] 862-2755

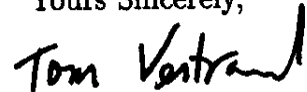
July 1, 1991

Dear Colleague,

We are looking into the possibility of distributing CD-ROMs containing data from the Gamma-Ray Spectrometer which flew aboard the Solar Maximum Mission satellite to the broader solar and astrophysical community. As many of you know, this highly successful instrument operated nearly continuously from March 1980 until December 1989. During that period the instrument measured spectra for more than 250 solar flares and nearly 175 cosmic gamma-ray bursts with an energy resolution of better than $\sim 7\%$ in the nuclear transition region ($300\text{keV} - 10\text{MeV}$). While it was designed primarily for measurements of transient emission, the excellent instrument stability has also allowed interesting measurements of "steady" gamma-ray sources. The range of discoveries made to date with the GRS data set has demonstrated the richness of these data. Cognizant of the value of these measurements, NASA management directed us to archive the nearly ten years of raw data and to develop analysis software for submission to a SMM Data Analysis Center (DAC) at Goddard Space Flight Center. That task is now complete. However, much of the data are still unanalyzed. For example, most of the flare measurements taken during the rise toward the 22nd Solar Maximum remain essentially unexplored. While interest in gamma-ray measurements has been increasing since the launch of the Gamma-Ray Observatory, it is our fear that much of this priceless SMM data will never be effectively analyzed.

We of the GRS team are seeking a mechanism for making the data set available and more accessible to a larger fraction of the scientific community. While an individual will be able to access the raw data through the SMM DAC at Goddard, we recognize that many investigators may be interested in "mining" the GRS data set at their home institutions. We are therefore examining the possibility of placing refined GRS solar flare and cosmic gamma-ray burst data sets along with appropriate background spectra onto CD-ROMs. If you would be interested in such an improved database, please return the enclosed postcard. We plan to judge the merit of this idea by the response we receive from this mailing.

Yours Sincerely,



Tom Vestrand
Principal Investigator
SMM GRS Team

***An Introduction to
The GRS Flare and Cosmic Gamma Ray Burst Data Set
Available at UNH from the
Gamma-Ray Spectrometer on SMM***

This mailing packet contains the following items:

- A quick overview of the Gamma Ray Spectrometer
- A partial listing of the scientific highlights of the mission
- A brief description of the GRS data set
- Instructions on accessing the GRS On-Line Information System
- A GRS CD ROM interest and Mailing list Reply card
- A 1.2 MB 5 1/4" diskette with sample Solar Flare and Cosmic Burst time history data

particle" and "Compton suppression" active shields which surround the MC and HEM. Table 1 summarizes some of the parameters for each sensor system.

Table 1. GRS Sensors

The X-RAY DETECTORS - Two Detectors X1 and X2, each produce a 4-Channel Spectrum every 1.024 seconds.	
Geometric area	7.9 cm ²
50% Transmission	X1 14 keV X2 35 keV
Energy Resolution	30% FWHM at 60 keV
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THE MAIN CHANNEL GAMMA RAY SPECTROMETER - Seven NaI Detectors produce a "SINGLES" and a "MULTIPLES" Spectrum every 16.384 seconds.	
Geometric Area	317 cm ²
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Main Channel Windows Energy Band	2.048 sec. readout time 3 windows covering 4.1 - 6.4 MeV

THE HIGH ENERGY MONITOR (MATRIX) - The seven NaI Detectors and the Back CsI detector produce an 18 element Matrix output every 2.048 seconds.	
Geometric Area	NaI = 317 cm ² , CsI = 491 cm ²
Energy Band	10 - 140 MeV

A Scientific Description of the GRS Instrument containing information about the GRS Instrument which is required for scientific analysis is available upon request. It includes preflight and inflight energy calibration information, a response function for each of the three sensors, and a description of the physical and electrical properties of the instrument including its location within the SMM spacecraft.

3 The GRS Data Set

The GRS data set spans nearly an entire decade of time (Feb. 1980 - Dec. 1989) and covers the energy loss region of 10keV - 140MeV. During this period the GRS observed more than 250 Solar Flares and some 175 Cosmic Gamma Ray Bursts. The entire GRS data set, which exceeds 70 Gigabytes, has been transferred from more than 3500 9-track tapes to sixty 8mm Exabyte tapes. This full data set contains more than 14 million 16.384 second Main Channel detector spectra covering the energy loss region of .3-10 MeV.

Since much of the interest in GRS data is directed toward the analysis of transient events, the GRS Flare and Cosmic burst events have been made into specialized data sets. A significant amount of processing has been done to each of these data sets. For the Flare data set where possible measurements from the same orbital period of the day before and the day after the event were

1 Introduction

Before the launch of GRO, Gamma-Ray Instruments which produced significant amounts of data and also had spectroscopic capabilities in the nuclear transition region (300 keV-10 MeV), were limited to just a few satellite experiments. Those instruments included the Solar Gamma-Ray Experiments on OSO-7, SMM and Hinotori and the two cosmic Gamma-Ray Experiments on HEAO-1 and HEAO-3. Of these, the Gamma-Ray Spectrometer on SMM is unique for at least two reasons: (1) the nearly 10 year length of its data set and (2) the excellent gain/operational stability of the instrument over its full working life. The GRS/SMM was originally designed to measure transient gamma-ray emission associated with solar flares and cosmic bursts. The catalog of more than 250 solar flares and approximately 175 cosmic bursts attests to its success in detecting transients. This flare data has been used to demonstrate the existence of nuclear line emission early in the impulsive phase of flares, to discover the directivity of high energy flare radiation, to demonstrate the existence of high energy solar neutrons and gamma-rays from the decay of neutral pions, to discover a 154 day period in flare activity, and to study elemental abundances of both the target particles and the accelerated particles at the flare site. These observations have revolutionized our understanding of the acceleration of particles to high energies during solar flares. The sensitivity of the GRS at high energies also allowed us to discover, contrary to expectations, that emission at energies >1 MeV is a common property of cosmic gamma-ray bursts.

Although designed as an instrument for the detection of transient emission, the long data base and excellent instrumental stability have allowed the study of "steady" gamma-ray emission. Galactic measurements include the positron annihilation line, the Al^{26} decay line, and the gamma-ray continuum up to energies of 10 MeV. Another highlight was the first detection of gamma-ray lines from SN1987a. Other results include detailed measurements of the terrestrial albedo gamma-ray line spectrum and the detection of particle and gamma-ray emission from orbiting nuclear reactors. The range of scientific discoveries and observations made to date with GRS/SMM indicate the richness of the GRS data set and suggests that it contains many more untapped scientific results.

2 GRS Instrument

The GRS Instrument consists of three, largely independent, sensor systems. These are the X-Ray Detectors (X1 and X2), the Main Channel Spectrometer (MC) and the High Energy Monitor (HEM) (see Figure 1).

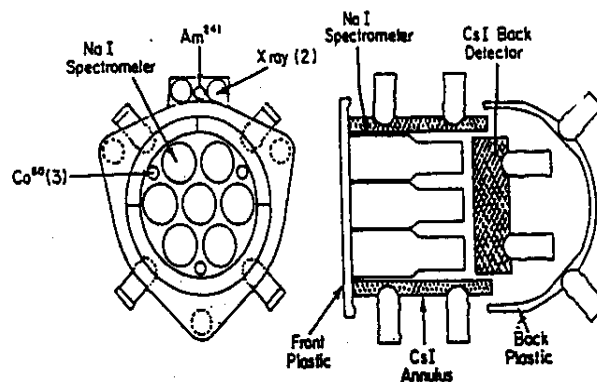


Figure 1. GRS Schematic Drawing

A schematic drawing of the GRS instrument showing the location of the three sensor systems; the X-ray detectors, the Main Channel Spectrometer, and the High Energy Monitor. Also shown are the location of the IFC calibration detectors and several shield elements.

All three sensor systems are designed to record the energy loss spectra produced by neutral radiation including, in the case of the HEM, solar neutrons. The instrument also includes several "charged

extracted and processed to coincide with the file containing the flare data. That data can be used to determine the best estimate background for a flare period.

A few sample energy bands for all the GRS Flares and Cosmic Bursts can be previewed by using UNH's GRS On-Line Information System. This Information system has several useful features which can be accessed via various networks. The details for using this system are described in section 5.

4 New Work at UNH for Solar Flares and Cosmic Bursts

The GRS group is currently working on a technique, using a relational data base, which will produce background estimates for any energy band, including the entire 476 channel spectrum, for any time interval during a flare. To do this, bit errors and other problems residing in the data used to determine backgrounds have been sorted through. This process is being completed only after a great deal of time and scientific understanding has been invested. It may therefore be possible in the near future to request a specific energy loss band for a flare interval and receive the data for that period along with its background. This eliminates a great deal of work and a possible source for error. Also in the near future, sample energy bands with backgrounds for flare data may be put onto the On-Line Information System where it can be previewed and automatically retrieved.

New methods for spectral unfolding of GRS data are also being developed at UNH. Those methods allow direct derivation of the incident photon fluxes from the observed count spectrum. Although this spectral unfolding will always require a level of expertise with the GRS instrument and gamma ray physics, the new method makes the process more straightforward.

5 The SMM GRS On-Line Information System at UNH

In order to make this rich data set more accessible to the scientific community the SMM GRS group at UNH has produced an on-line menu driven information system which allows any user to browse the GRS Flare and Cosmic Burst data sets. The on-line system can be used to find the status of the GRS instrument at any moment during its decade long mission, to plot sample energy windows for any GRS flare or cosmic burst, and to mail sample data files for any flare or burst over the network.

The UNH GRS On-Line Information System can be reached via SPAN or the Internet (by Telnet) using the following addresses:

SPAN

Host Address: 7100::
USERNAME: GRSDATA

Internet

Telnet Address: UNHSMM.UNH.EDU
USERNAME: GRSDATA

No password is necessary.

For More Information concerning GRS Data please contact one of the following people at UNH:

Tom Vestrand (GRS PI)

Telephone: (603) 862-2653

SPAN: 7103::VESTRAND Internet: VESTRAND@UNHSMM.UNH.EDU

Dave Forrest (GRS Instrument Scientist)

Telephone: (603) 862-3705

For Information about the On-Line Information System contact:

Ken Levenson (GRS Data Manager)

Telephone: (603) 862-3708

SPAN: 7100::LEVENSON Internet: LEVENSON@UNHSMM.UNH.EDU